Earth and Space Science I

Indiana's academic standards for Earth and Space Science I contain two standards, The Principles of Earth and Space Science and Historical Perspectives of Earth and Space Science. Ideas listed underneath each standard build the framework for a first-year Earth and Space Science course.

In addition, ideas from the following four supporting themes will enable students to understand that science, mathematics, and technology are interdependent human enterprises, and that scientific knowledge and scientific thinking serve both individual and community purposes.

The Nature of Science and Technology

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the other. This first theme draws portraits of science and technology that emphasize their roles in the scientific endeavor and reveal some of the similarities and connections between them. In order for students to truly understand the nature of science and technology, they must model the process of scientific investigation through inquiries, fieldwork, lab work, etc. Through these experiences, students will practice designing investigations and experiments, making observations, and formulating theories based on evidence.

Scientific Thinking

There are certain thinking skills associated with science, mathematics, and technology that young people need to develop during their school years. These are mostly, but not exclusively, mathematical and logical skills that are essential tools for both formal and informal learning and for a lifetime of participation in society as a whole. Good communication is also essential in order to both receive and disseminate information and to understand others' ideas as well as have one's own ideas understood. Writing, in the form of journals, essays, lab reports, procedural summaries, etc., should be an integral component of students' experiences in Earth and Space Science I.

The Mathematical World

Mathematics is essentially a process of thinking that involves building and applying abstract, logically connected networks of ideas. These ideas often arise from the need to solve problems in science, technology, and everyday life – problems ranging from how to model certain aspects of a complex scientific problem to how to balance a checkbook. Students should apply mathematics in scientific contexts and understand that mathematics is a tool used in science to help solve problems, make decisions, and understand the world around them.

Common Themes

Some important themes, such as systems, models, constancy, and change, pervade science, mathematics, and technology and appear over and over again, whether we are looking at ancient civilization, the human body, or a comet. These ideas transcend disciplinary boundaries and prove fruitful in explanation, in theory, in observation, and in design. These themes provide students with opportunities to engage in long-term and on-going laboratory and fieldwork and to understand the role of change over time in studying concepts in Earth and Space Science I.

Standard 1

Principles of Earth and Space Science

Students investigate, through laboratory and fieldwork, the universe, Earth, and the processes that shape Earth. They understand that Earth operates as a collection of interconnected systems that may be changing or may be in equilibrium. Students connect the concepts of energy, matter, conservation, and gravitation to Earth, the solar system, and the universe. Students utilize knowledge of the materials and processes of Earth, planets, and stars in the context of the scales of time and size.

The Universe

ES.1.1 Understand and discuss the nebular theory concerning the formation of solar systems. Include in the discussion the roles of planetesimals and protoplanets.

ES.1.2 Differentiate between the different types of stars found on the Hertzsprung-Russell Diagram. Compare and contrast the evolution of stars of different masses. Understand and discuss the basics of the fusion processes that are the source of energy of stars.

ES.1.3 Compare and contrast the differences in size, temperature, and age between our sun and other stars.

ES.1.4 Describe Hubble's law. Identify and understand that the "Big Bang" theory is the most widely accepted theory explaining the formation of the universe.

ES.1.5 Understand and explain the relationship between planetary systems, stars, multiple-star systems, star clusters, galaxies, and galactic groups in the universe.

ES.1.6 Discuss how manned and unmanned space vehicles can be used to increase our knowledge and understanding of the universe.

ES.1.7 Describe the characteristics and motions of the various kinds of objects in our solar system, including planets, satellites, comets, and asteroids. Explain that Kepler's laws determine the orbits of the planets.

ES.1.8 Discuss the role of sophisticated technology, such as telescopes, computers, space probes, and particle accelerators, in making computer simulations and mathematical models in order to form a scientific account of the universe.

ES.1.9 Recognize and explain that the concept of conservation of energy is at the heart of advances in fields as diverse as the study of nuclear particles and the study of the origin of the universe.

Earth

ES.1.10 Recognize and describe that earth sciences address planet-wide interacting systems, including the oceans, the air, the solid earth, and life on Earth, as well as interactions with the Solar System.

ES.1.11 Examine the structure, composition, and function of Earth's atmosphere. Include the role of living organisms in the cycling of atmospheric gases.

ES.1.12 Describe the role of photosynthetic plants in changing Earth's atmosphere.

ES.1.13 Explain the importance of heat transfer between and within the atmosphere, land masses, and oceans.

ES.1.14 Understand and explain the role of differential heating and the role of Earth's rotation on the movement of air around the planet.

ES.1.15 Understand and describe the origin, life cycle, behavior, and prediction of weather systems.

ES.1.16 Investigate the causes of severe weather and propose appropriate safety measures that can be taken in the event of severe weather.

ES.1.17 Describe the development and dynamics of climatic changes over time, such as the cycles of glaciation.

ES.1.18 Demonstrate the possible effects of atmospheric changes brought on by things such as acid rain, smoke, volcanic dust, greenhouse gases, and ozone depletion.

ES.1.19 Identify and discuss the effects of gravity on the waters of Earth. Include both the flow of streams and the movement of tides.

ES.1.20 Describe the relationship among ground water, surface water, and glacial systems.

ES.1.21 Identify the various processes that are involved in the water cycle.

ES.1.22 Compare the properties of rocks and minerals and their uses.

Processes That Shape Earth

ES.1.23 Explain motions, transformations, and locations of materials in Earth's lithosphere and interior. For example, describe the movement of the plates that make up Earth's crust and the resulting formation of earthquakes, volcanoes, trenches, and mountains.

ES.1.24 Understand and discuss continental drift, sea-floor spreading, and plate tectonics. Include evidence that supports the movement of the plates, such as magnetic stripes on the ocean floor, fossil evidence on separate continents, and the continuity of geological features.

ES.1.25 Investigate and discuss the origin of various landforms, such as mountains and rivers, and how they affect and are affected by human activities.

ES.1.26 Differentiate among the processes of weathering, erosion, transportation of materials, deposition, and soil formation.

ES.1.27 Illustrate the various processes that are involved in the rock cycle and discuss how the total amount of material stays the same through formation, weathering, sedimentation, and reformation.

ES.1.28 Discuss geologic evidence, including fossils and radioactive dating, in relation to Earth's past.

ES.1.29 Recognize and explain that in geologic change, the present arises from the materials of the past in ways that can be explained according to the same physical and chemical laws.

Standard 2

Historical Perspectives of Earth and Space Science

Students gain understanding of how the scientific enterprise operates through examples of historical events. Through the study of these events, they understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators.

ES.2.1 Understand and explain that Claudius Ptolemy, an astronomer living in the second century, devised a powerful mathematical model of the universe based on constant motion in perfect circles and circles on circles. Further understand that with the model, he was able to predict the motions of the sun, moon, and stars, and even of the irregular "wandering stars" now called planets.

ES.2.2 Understand that and describe how in the sixteenth century the Polish astronomer Nicholas Copernicus suggested that all those same motions outlined by Ptolemy could be explained by imagining that Earth was turning on its axis once a day and orbiting around the sun once a year. Note that this explanation was rejected by nearly everyone because it violated common sense and required the universe to be unbelievably large. Also understand that Copernicus's ideas flew in the face of belief, universally held at the time, that Earth was at the center of the universe.

ES.2.3 Understand that and describe how Johannes Kepler, a German astronomer who lived at about the same time as Galileo, used the unprecedented precise observational data of the Danish astronomer Tycho Brahe. Know that Kepler showed mathematically that Copernicus's idea of a sun-centered system worked better than any other system if uniform circular motion was replaced with variable-speed, but predictable, motion along off-center ellipses.

ES.2.4 Explain that by using the newly invented telescope to study the sky, Galileo made many discoveries that supported the ideas of Copernicus. Recognize that it was Galileo who found the moons of Jupiter, sunspots, craters and mountains on the moon, the phases of Venus, and many more stars than were visible to the unaided eye.

ES.2.5 Explain that the idea that Earth might be vastly older than most people believed made little headway in science until the work of Lyell and Hutton.

ES.2.6 Describe that early in the twentieth century the German scientist Alfred Wegener reintroduced the idea of moving continents, adding such evidence as the underwater shapes of the continents, the similarity of life forms and land forms in corresponding parts of Africa and South America, and the increasing separation of Greenland and Europe. Also know that very few contemporary scientists adopted his theory because Wegener was unable to propose a plausible mechanism for motion.

ES.2.7 Explain that the theory of plate tectonics was finally accepted by the scientific community in the 1960s when further evidence had accumulated in support of it. Understand that the theory was seen to provide an explanation for a diverse array of seemingly unrelated phenomena and there was a scientifically sound physical explanation of how such movement could occur.